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Coastal Engineering Technical Note

CLARIFICATION OF WAVE HEIGHT PARAMETERS

PURPOSE: To clarify commonly used wave height parameters.

GENERAL: Ocean wave heights are characterized by a variety of different parameters. These parameters are useful tools in the solution of various coastal problems, but their interrelationship is sometimes unclear. Confusion about these parameters can lead to their misuse in coastal engineering work. Wave height parameters can be considered in terms of three classes: statistical base, energy base, and monochromatic base. The classes are defined as follows:

Statistical base: These parameters are based on statistics of heights of individual waves in an irregular sea and include

H_s or $H_{1/3}$ = average height of highest one-third of waves

H_1 = average height of highest one percent of waves

H_{rms} = root mean square wave height

H_{max} = maximum individual wave height

Energy base: These parameters are based on the energy contained in the sea surface, such as

σ = standard deviation of sea surface elevations

H_{m_o} = four times the standard deviation of sea surface elevations

Monochromatic base: These parameters are based on uniform rather than irregular waves, such as

H = wave height

H_b = wave height at breaking induced by shallow water depth

SOURCE OF CONFUSION: Wave height parameters within each class are clearly and easily interrelated. For example, H_s is approximately equal to $1.416H_{rms}$, as discussed in the SPM (Section 3.22).

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Confusion often arises when parameters from different classes must be interrelated. For example, if H_{m_o} is known for a particular shallow-water site, how can H_1 be estimated? Efforts of coastal engineers to clearly specify the relationship between parameters in different classes are complicated by a dependence on water depth and wave characteristics such as steepness.

Further confusion is often introduced by indiscriminate use of the term "significant wave height" to denote both H_s and H_{m_o}. These two parameters are usually equivalent in deep water, but H_s may be 15 percent greater than H_{m_o} in shallow water where waves are beginning to break. Although the traditional definition of significant wave height is that of H_s, H_{m_o} is provided in most analyses of digital wave records and referred to as "significant wave height." The distinction between H_s and H_{m_o} is not made in the SPM; and small errors can be expected in the equations relating parameters from different classes in Section 3.23, especially for near-breaking wave conditions.

HIERARCHY OF PARAMETERS: A qualitative aid for dealing with wave height parameters is provided below by a list of parameters in descending order of magnitude for both deep and shallow water.

HIERARCHY OF WAVE HEIGHT PARAMETERS

Deep Water	Shallow Water
H_{max}	$H_b = H_{max}$
H_1	H_1
$H_{m_o} = H_s$	H_s
	H_{m_o}
H_{rms}	H_{rms}

REMARKS: Several very important concepts are illustrated in the hierarchy of parameters for shallow water. The depth-limited breaker height, H_b, is greater than (not equivalent to) H_s. In fact, for a specific depth of water, H_b is equivalent to the expected maximum wave height. Further, the

hierarchy indicates that H_s can be greater than H_{m_o}. This distinction results from the nonsinusoidal shape of waves in shallow water. The energy in a wave train is better estimated through H_{m_o} than through H_s.

CONCLUSION: Users of wave height parameters must be aware that the parameters obtained for use in coastal engineering design should match the parameters required in the design procedures. In particular, users should note that for most measured shallow-water data, the energy-based parameter H_{m_o} rather than the statistical-based parameter H_s is computed and referred to as the significant wave height.

ADDITIONAL INFORMATION: Contact Ed Thompson (WESCR-O), CERC Coastal Oceanography Branch (601) 634-2027

REFERENCE:

Shore Protection Manual. 1984. 4th ed., 2 vols, U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, U.S. Government Printing Office, Washington, D.C.